Office Action Summary	Application No.	Applicant(s)	
	10/581,256	OKUNE ET AL.	
	Examiner	Art Unit	
	MAHMOUD DAHIMENE	1792	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *04 February 2010*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *20,21,24-27 and 30-33* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *20,21,24-27 and 30-33* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☒ Interview Summary (PTO-413) Paper No(s)/Mail Date. *3/11/10*.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

EXAMINER'S AMENDMENT

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with Jeffrey Howell on 3/9/2010.

The application has been amended as follows:

Claim 34 drawn to an apparatus is canceled.

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to

consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

3. Claims 20, 21, 24, 25, 26, 27, 30, 31, 33, are rejected under 35 U.S.C. 103(a) as being unpatentable over Lahaug (US 6,338,938) in view of Mimura et al. (US 7,022,616) and McReynolds (US 6,191,043).

4. Regarding claims 20, 21, Lahaug discloses a method of forming semiconductor devices wherein a silicon dry etch utilizing SF6 and helium is used without oxygen gas (column 3, line 49).

5. It is noted that Lahaug is silent about electricity having a frequency equal to or more than 27 MHz.

6. Mimura discloses a method of high speed silicon etching wherein both the etching rate and selectivity increase when the RF frequency is near 27 MHz or higher (fig. 8) (column 8, line 18) .The frequency of 27 MHz or more is preferable for increasing the plasma density above the silicon wafer (column 8, line 6). Mimura appears to suggest that the preferred frequency is independent of the specific gas chemistry used for etching since a number of etching chemistries are used.

7. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Lahaug to perform the etching with an RF frequency of 27 MHz or higher because Mimura discloses a method of high speed silicon etching wherein both the etching rate and selectivity increase when the RF frequency is near 27 MHz or higher (fig. 8) (column 8, line 18) .The frequency of 27 MHz or more is preferable for increasing the plasma density above the silicon wafer

(column 8, line 6). Mimura appears to suggest that the preferred frequency is independent of the specific gas chemistry used for etching since a number of etching chemistries are used.

8. One of ordinary skill in the art would have been motivated to modify the process of Lahaug to perform the etching with an RF frequency of 27 MHz or higher in order to increase the plasma density which will result in higher etch rates and etch selectivity.

9. It is also noted that Lahaug is silent about the specific volumetric ration of He versusthe total flow rate of the etching gas being 80%.

McReynolds teaches SF.sub.6 /O.sub.2 /He plasma etch chemistry is conventionally used for etching silicon (column 1, line 34). On the top surface of the chamber 304, there is disposed a quartz window 306, which serves as a transparent medium to allow RF energy to enter the chamber (figure 3). McReynolds cites "Other gases that may be substituted for SF.sub.6 include C.sub.4 F.sub.8, CF.sub.4, NF.sub.3, and CHF.sub.3." (column 5, line 19).

In Table 2 McReynolds teaches that the flow rate of each individual gas, in a silicon etching method, is adjustable, including the flow rate of He gas which is a result effective variable. In the examples provided in Table 2 of McReynolds, there are cases where He flow is 80% or more relative to the total gas flow. It is noted that McReynolds uses O2 gas in etching. The reference of McReynolds is not relied on to teach and O2 free etching method, Lahaug teaches SF6 and He is sufficient to etch silicon. The reference of McReynolds is only relied on to teach the flow rate of each individual gas, in a silicon etching method, is adjustable, including the flow rate of He gas which is a

result effective variable. In table 2 of McReynolds, removing Argon gas form the etching gas chemistry will result in a volumetric flow rate of the helium (He) gas introduced into the treatment chamber is equal to 81.63%, which is more than 80% of a total volumetric flow rate of the etching gas. ([400/(50+20+10+400)] = 0.8163).

10. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Lahaug to adjust the He flow rate relative to the total gas flow rate because McReynolds teaches that the flow rate of each individual gas, in a silicon etching method, is adjustable, including the flow rate of He gas which is a result effective variable. In the examples provided in Table 2 of McReynolds, there are cases where He flow is 80% or more relative to the total gas flow, And since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art.

As to claim 24, 25, it is noted Lahaug is silent about an inside wall of the hamber being quartz. As discussed above McReynolds discloses such a feature.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Lahaug to include a quartz window because McReynolds teaches it.

One of ordinary skill in the art would have been motivated to modify the process of Lahaug to include a quartz window in order to serve as a transparent medium to allow RF energy to enter the chamber (figure 3).

Regarding claims 26, 27, it is noted that Lahaug is silent about an additional CL2. McReynolds provides etching parameters in Table 2, where Helium gas

flow is used between 100 to 400 sccm. When considered with relative to the range of the flow of the other SF_6, Cl_2, Ar gases, the He and Cl2 of McReynolds gas flows overlap the ranges claimed by the applicant.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Lahaug by adding Cl2 to the silicon etching method in any amount including 10% of total flow of Lahaug because McReynolds teaches it is conventional do so.

One of ordinary skill in the art would have been motivated to modify the process of Lahaug by adding Cl2 to the silicon etching method in order to further control etch rate and etch profile and selectivity. McReynolds teaches Cl2 is an adjustable result effective parameter, it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art.

As to claims 30, 31, it is noted that Lahaug is silent about adding polymer forming gases, McReynolds teaches Other gases that may be substituted for SF.sub.6 include C.sub.4 F.sub.8, CF.sub.4, NF.sub.3, and CHF.sub.3. Since it is prima facie obvious to combine two compositions each of which is taught by the prior art to be useful for the same purpose, in order to form a third composition to be used for the very same purpose, then, for instance combining SF.sub.6 and CF.sub.4 (or C.sub.4 F.sub.8, NF.sub.3, and CHF.sub.3 all of which are polymer forming gases) is obvious since McReynolds teaches the two gases accomplish equivalent function as far as etching silicon. Since the applicant uses the open language expression "method comprising" which is interpreted by the examiner as more etching gases are comprised, it is hard, if

not impossible to predict what removing the (CF_4) gas will do to the etching rate since there is no basis for comparison, namely the (potentially used) other gases have not been specified by applicant in the open language claims. In the case of McReynolds removing the (CF_4) gas will definitely reduce the etching rate when (CF_4) gas (in case CF_4 is substituted for SF6) is the only gas relied on to deliver the fluorine species for etching the layer since no other etching gas remains other than O2 and Helium which lack the ability of providing fluorine.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Lahaug by adding polymer forming gases because McReynolds teaches it is beneficial to do so.

One of ordinary skill in the art would have been motivated to modify the process of Lahaug by adding polymer forming gases in order to further control the etching profile of the etched feature as to polymer is conventionally used for sidewall passivation.

Claim Rejections - 35 USC § 103

11. Claims 32, are rejected under 35 U.S.C. 103(a) as being unpatentable over Lahaug (US 6,338,938) in view of Mimura et al. (US 7,022,616) and McReynolds (US 6,191,043) as applied to claims to vlais 20, 21, 24-27, 30-31, above and further in view of Okumura (US 2003/0034542).

12. It is noted that Lahaug is silent about a second etching step.

Okumura discloses "Next, as shown in FIG. 11A, the photoresist mask 113 is removed. Next, as shown in FIG. 11B, with the silicon oxide layer 112 used as a mask, RIE is performed using SF.sub.6 and CF.sub.4 to selectively etch out the silicon plate 16a" (paragraph 01 013). The reference of Okumura is relied on only to teach that silicon is selectively etched using SF.sub.6 and CF.sub.4, it is not relied on to teach device manufacturing.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Mimura modified by Mimura and McReynolds to split the etching process into two steps because McReynolds teaches a step (first step) using SF.sub.6 /O.sub.2 /He plasma etch chemistry is conventionally used for etching silicon and combining SF.sub.6 and CF.sub.4 (or C.sub.4 F.sub.8, NF.sub.3, and CHF.sub.3 all of which are polymer forming gases) is obvious since McReynolds teaches the two gases accomplish equivalent function as far as etching silicon.

One of ordinary skill in the art would have been motivated to split the etching process of Lahaug into two steps when selectivity to an underlayer silicon oxide is required. One of ordinary skill in the art would have been motivated to select SF.sub.6 and CF.sub.4 as the second step when the first etch step does not require selectivity in the etching, but the second step which exposes an underlayer requires selectivity to the underlayer.

Response to Arguments

13. Applicant's arguments, 2/4/10, with respect to the rejection(s) of all pending claims have been fully considered and are persuasive in view of the fact that Applicant's argument stating "*Nagata discloses, in FIG. 5 (see the black and white dots), merely that an etching rate is monotonically increased as concentration of 02 gas is decreased in etching with an etching temperature of 400°C.....the etching temperature in McReynolds is significantly different from that of Nagata. As a result, it would have been impossible for one of ordinary skill in the art to modify McReynolds with the teachings of FIG. 5 of Nagata. That is, since Nagata discloses an etching temperature of 400°C, one of ordinary skill in the art would not have modified McReynolds with the Nagata etching, since McReynolds etching is performed between 20°C and 70°C*" is persuasive, since Nagata's disclosure shows that the effect of temperature can significantly affect the etching rates silicon and the etching selectivity to SiO2. Nagata's figure 5 only shows the effect of O2 in NF3 on the SiO2 etching rate at 400 degrees C, not at 20 to 70 degrees C, which is the etching temperature used by McReynolds. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of Lahaug and Mimura. The office action has been updated to address all applicant's limitations.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MAHMOUD DAHIMENE whose telephone number is (571)272-2410. The examiner can normally be reached on week days from 8:00 AM. to 5:00 PM..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on (571) 272-1465. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/M. D./
Examiner, Art Unit 1792

/Nadine G Norton/
Supervisory Patent Examiner, Art Unit 1792